MONROE

Formula Problem Simplification

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MONROE FORMULA PROBLEM SIMPLIFICATION

UNIT NO. 1

HOW TO SIMPLIFY FIGURE PROBLEMS

Elemental Algebra with its accompanying symbols is vitally important to all Monroe representatives in simplifying the study of figure work encountered in all lines of business, in developing short cuts for this figure work, in determining the best calculator model to recommend and in presenting a written recommendation to the prospect to secure an order.

The use of symbols makes it easier in most problems to arrive at an understanding or solution of the problem than the juggling of actual quantities which may involve addition, subtraction, multiplication, division and fractions, roots or powers. It is easier to first perform these operations with letters and symbols.

Formulas tie in with arithmetic. They are an easy method of passing on the solution of problems or the reasoning necessary for the solution of a problem. Formulas provide the means for determining the shortest route to the result.

A clear understanding of simple basic formulas will prove that the majority of figure problems in many lines of business can be solved by comparatively few formulas despite the varied differences in the nature of these problems.

Formulas clarify simplification of figure work and suggest machine short cuts including the best Monroe model for the figure job. Study and practice in the following units of instruction will simplify your study of a prospect's requirements, will help to eliminate competition and, if consistently used from your approach to final proposal, should increase your sales of calculating machines.

SIMPLE SYMBOLS AND SIGNS

It is only necessary to use and recognize a few algebraic symbols and signs for Monroe Formula Problem Simplification. But it is important to thoroughly understand what these signs and symbols represent.

SIGNS		EXAMPLE
$=$	Equals	$\frac{12}{4} = 3$
$+$	Plus, Positive, Add	$3 + 4 = 7$
$-$	Minus, Negative, Subtract	$5 - 1 = 4$
$\pm$	Plus or Minus; Positive or Negative	$6 \pm 3 = 9$ or 3
$\times$	Multiplied by, Times	$5 \times 7 = 35$
$\div$	Divided by	$12 \div 2 = 6$
( )	Parentheses	$2(3 + 4) = 14$
[ ]	Brackets	$5[2(3 + 4)] = 70$
$\sqrt{\ }$	Root - Radical Sign	$\sqrt{64} = 8$

GLOSSARY AND SYMBOLS

SYMBOL - A letter, mark or character representing quantity or indicating an operation.

ALGEBRAIC EXPRESSION - Any combination of letters, numerals and symbols of operation.

FACTOR - Each of the quantities which, multiplied together or divided into each other, form a product or result, is called a factor of the product or result. Factors can be numerical or literal. In an expression 3bc and 7mn, the numbers 3 and 7 are NUMERICAL factors and the letters b and c, and m and n, respectively are LITERAL factors.

COEFFICIENT - Usually indicates a numerical factor. In expression 10ab the numeral 10 is the coefficient of ab. If there is no coefficient 1 is implied, $a \times b = 1a \times 1b$.

ALGEBRAIC TERM - Parts which are separated by + or - signs, with the signs in front are called terms. Example: 2ab - 3m, there are two terms.

SYMBOLS - Any letter in the alphabet can be substituted as a symbol for any factor. Unknown factors, such as the result to be secured, are generally represented by the letters x and y. Letter symbols are not capitalized letters. Example: $45 \times 23 = ?$ Symbolized $a \times b = x$.

COMMON FACTOR - Any letter or symbol in a term of an expression which is common to a letter in another term of the same expression.

EQUATION - An equation is an expression of equality between two quantities or expressions.

TRANSPOSING - Any shifting of terms in an equation from one side to the other and changing their signs.

MONROE FORMULA PROBLEM SIMPLIFICATION

UNIT NO. 2

FUNDAMENTAL RULES OF ALGEBRA

In Unit No. 1, the value of formulas in the handling of business problems was described and the essential symbols and signs to be used in simplifying problems were outlined and discussed. It is necessary now to outline the fundamental rules of algebra so that the simple formulas required can be properly used in handling addition, subtraction, multiplication and division of symbols.

ADDITION

SIMILAR TERMS

EXAMPLE: $2d + 3d + d + 7d = 13d$
Since all terms are similar, they can be easily added as they are in arithmetic.

DISSIMILAR TERMS

EXAMPLE: $2a + 3b + 4c + 5d$
Since these terms are dissimilar, they cannot be added as in arithmetic.

POSITIVE AND NEGATIVE QUANTITIES

RULE: In adding a positive and negative number, subtract the number with the lesser numerical value from the number with the greater numerical value, and affix to the result the sign of the number with the greater numerical value. If the numerical values are equal, the terms cancel each other.

EXAMPLE: Find value of $R - Ps + iP - q + 2Ps - 7iP - R$

Rearrange

$$\begin{array}{r} R - Ps + ip - q \\ \underline{-\ R + 2Ps - 7iP \qquad\quad} \\ 0 + Ps - 6iP - q \text{ or } Ps - 61P - q \end{array}$$

SUBTRACTION

RULE: To subtract one quantity from another, change the sign of the quantity to be subtracted and add according to the rule of algebraic addition.

EXAMPLES:

NUMERICAL	SYMBOLICAL
$(+18) - (+12) = +6$	$(+a) - (+b) = a - b$
$(-18) - (+12) = -30$	$(-a) - (+b) = -a - b$
$(+18) - (-12) = +30$	$(+a) - (-b) = a + b$
$(-18) - (-12) = -6$	$(-a) - (-b) = -a + b$

ORDER OF FUNDAMENTAL OPERATIONS

The value of expressions in formulas depends upon the order in which operations are performed.

EXAMPLE: Let $N = 2.$ and $i = .05$ in following expression. Then if proper order is used, the value of $(1 + Ni) = 1 + (2 \times .05) = 1.10$. If improper order is used, here is the incorrect result: $1 + 2 \times .05 = 3 \times .05 = .15$

RULE 1 A succession of multiplications and divisions shall be performed in the order in which they occur.

RULE 2 A succession of additions and subtractions shall be performed in the order which is most convenient.

RULE 3 A succession of all four fundamental operations shall be performed in accordance with Rules Nos. 1 and 2, but the multiplication and division must be performed before the addition and subtraction.

EXAMPLE:

$$\begin{aligned} & 15 + (13 \times 3) - 11 - (4 \times 6) \\ &= 15 + 39 - 11 - 24 \\ &= 54 - 35 \\ &= 19 \end{aligned}$$

AND

$$\begin{aligned} & (21 \div 3) + (2 \times 8) \div 4 + (5 \times 9) \div 3 \\ &= 7 + (16 \div 4) + (45 \div 3) \\ &= 7 + 4 + 15 \\ &= 26 \end{aligned}$$

PARENTHESES AND BRACKETS

In Unit No. 1, parentheses and brackets were shown under signs. These signs are used to enclose terms that are treated as one quantity. It is customary to use parentheses where one combination of terms is to be treated as one quantity and when two combinations of terms are to be treated as one quantity, brackets are combined with parentheses.

RULE 1 When term in parentheses is preceded by a positive or + sign, the parentheses may be removed WITHOUT CHANGING the signs of the enclosed terms.

RULE 2 If the term in parentheses is preceded by a negative or - sign, it is necessary, when removing the parentheses, to CHANGE EACH of the positive and negative signs of the enclosed terms to the opposite sign.

RULE 3 Conversely, if one or more terms are to be enclosed in parentheses Rules Nos. 1 and 2 also apply to the signs of the terms enclosed as they did to the removal of parentheses.

EXAMPLES:

REMOVING PARENTHESES

BEFORE	AFTER
$a + b - c + (m - n)$	$a + b - c + m - n$
$a + b - c - (m - n + h)$	$a + b - c - m + n - h$

ENCLOSING IN PARENTHESES

BEFORE	AFTER
$a - b + c + m - n$	$a - b + (c + m - n)$
$d - e - f + r - s$	$d - (e + f - r + s)$

PARENTHESES OR BRACKETS IN MULTIPLICATION

It is unnecessary to use the multiplication $\times$ sign before parentheses or brackets.

EXAMPLE:

$2a \times (b + c + d)$ may be $2a(b + c + d)$
and the order is immaterial for
$2a(b + c + d)$ is exactly the same as $(b + c + d)2a$

SIMPLIFYING EXPRESSIONS

There are frequently several steps to simplifying expressions to reduce terms, factors and symbols, and the following example well illustrates the combined use of parentheses and brackets.

EXAMPLE:

$1 - [1 - (1 + j)]$
$1 - [1 - 1 - j]$ Removing Parentheses
$1 - [\ - j\ ]$ Simplifying
$1 + j$ Removing Brackets

MULTIPLICATION

RULE 1 To multiply one term by another, multiply the numerical coefficient and annex the letters. If, in the terms to be multiplied, there are unlike letters, each of these letters are written in the product.

EXAMPLE:

$$a \times b \times 60 = 60ab$$
$$6a \times 2b \times 3c = 36abc$$
$$\tfrac{1}{2} \times j \times F \times r = \frac{jFr}{2}$$
$$\tfrac{1}{2}j \times 4F = 2jF$$

NEGATIVE QUANTITIES

RULE 1 When multiplying a negative quantity by a positive or vice versa, the product will be negative.

EXAMPLE:

$$-5m \times 3n = -15mn$$

RULE 2 When multiplying a negative quantity by another negative quantity, the product will be positive.

EXAMPLE:

$$(-4)\ (-3) = +12$$
$$(-a)\ (-b) = +ab$$

MULTIPLE TERMS POSITIVE AND NEGATIVE

RULE To multiply one number or symbol by another multiply by their values. Prefix a plus(+)sign when the signs of both quantities are alike (either + or -) and a minus sign when they are unlike.

EXAMPLE:

$$a(b + cd - i) = ab + acd - ai$$
$$3b(-4a - 6c + d) = -12ab - 18bc + 3bd$$
$$-2c(3b - 4d + e) = -6bc + 8cd - 2ce$$
$$P(1 + ni) = P + Pni$$

NOTE: It is best to simplify first within parentheses performing multiplications or divisions;then do the addition or subtraction necessary.

EXAMPLE:

$$P = 600(1 + \tfrac{1}{4} \times .05)\ (1 - \tfrac{1}{4} \times .06)$$
$$P = 600(1 + \frac{.05}{4})\ (1 - \frac{.06}{4})$$
$$P = 600(1 + .0125)\ (1 - .015)$$
$$P = 600 \times 1.0125 \times .985$$
$$P = 598.39$$

DIVISION - POSITIVE AND NEGATIVE QUANTITIES

RULE Coefficients are first divided as they are in arithmetic, symbols are then divided (cancelled) when alike but only indicated when they are unlike. The rule for signs is the same as for multiplication.

EXAMPLE:

$$\frac{4a}{2a} = 2$$

$$\frac{-S}{-S} = 1$$

$$\frac{-P}{-2P} = \frac{1}{2}$$

$$\frac{4a}{-2} = -2a$$

$$\frac{3a + 9b - 24c}{3} = a + 3b - 8c$$

COMMON FACTOR

RULE To find the factors of an expression having a common factor, divide each term of the expression by the common factor, writing the common factor and the quotient as factors of the expression.

EXAMPLE:

$ab + ac$ a is the common factor
$b + c$ quotient after dividing by a
$a(b + c)$ Two factors
also $d^2 + nd = d(d + n)$

EQUATION

An equation is an expression of equality between two quantities or expressions. The object is to reduce every equation to its simplest form having the unknown quantities on the left side of the equality sign = . This frequently requires the shifting of terms which is governed by certain fundamental principles called axioms.

Axiom I Things equal to the same thing are equal to each other.

EXAMPLE:

If $x = y$
and $y = 6$
then $y = 6$

Axiom 2 If equals are added to equals the results are equal. Thus equals can be added to both sides of an equation without destroying the equality.

EXAMPLE:

$4 + 2 = 6$ we add 3 to both sides
$4 + 2 = 3 = 6 + 3$
or $9 = 9$

Axiom 3 If equals are subtracted from equals, the results are equal. Thus equals can be subtracted from both sides of an equation without destroying the equality.

EXAMPLE:

$y + 6 = 21$ We subtract 6 from both sides
$y + 6 - 6 = 21 - 6$
$y = 15$

Axiom 4 If equals are multiplied by equals, the results are equal.

EXAMPLE:

$5 + 2 = 7$ We multiply both sides by 2
$2(5 + 2) = 2(7)$
$14 = 14$

EXAMPLE:

Illustrating value in solving unknown

$\frac{M}{3} = 8$ Multiplying both sides by 3

$\frac{M}{3} \times 3 = 8 \times 3$ or

$M = 24$

Axiom 5 If equals are divided by equals the results are equal.

EXAMPLE:

$4 + 5 = 9$ Divide both sides by 3

$\frac{4 + 5}{3} = \frac{9}{3}$

$3 = 3$

EXAMPLE:

Illustrating value in solving unknown

$5S - 10 = 20$ Divide both sides by 5
$\frac{5S - 10}{5} = \frac{20}{5}$
$S - 2 = 4$ Then add 2 to each side and
$S = 6$

TRANSPOSING TERMS

RULE Any term of an equation may be transposed to the other side, provided the sign of the term is changed. This operation is the equivalent of adding or subtracting the same quantity to both sides as outlined in Axioms.

EXAMPLE:

$2j + 4 = 16 - j$	
$2j + j + 4 = 16$	Transposing j
$2j + j = 16 - 4$	Transposing 4
$3j = 12$	Collection of like terms
$j = 4$	By Axiom 5 dividing both sides by 3

MONROE FORMULA PROBLEM SIMPLIFICATION

UNIT NO. 3

BASIC FORMULAS FOR FUNDAMENTAL OPERATIONS

It is important that we understand how to reduce the fundamental operations of arithmetic to symbols and formulas before we learn how to reduce typical business problems to the same form. This process you will discover is a very simple one. We merely substitute for any amount or factor in a given arithmetical problem a letter of the alphabet starting with the letter a. It is customary in formula construction to use the letters x, y and z for the unknown factors which is generally the result or answer.

The signs and rules outlined in Units 1 and 2 of this course are then used with the symbols and formulas you have developed from the arithmetical problem. We illustrate some of these basic formulas for fundamental operations showing how they were developed from the arithmetical problem.

NO.	TYPE OF WORK	ARITHMETICAL SOLUTION	FORMULA
1	Addition	43.50 + 22.95 + 1.50 + 3.75 = ?	$a+b+c+d=x$
2	Addition of Constant	36.50 + 43.75 = ?	$a+b=x$
		22.85 + 43.75 = ?	$c+b=x$
		119.40 + 43.75 = ?	$d+b=x$
3	Subtraction	79.50 - 38.82 = ?	$a-b=x$
4	Subtraction of Constant	112.80 - 41.35 = ?	$a-b=x$
		89.35 - 41.35 = ?	$c-b=x$
		50.50 - 41.35 = ?	$d-b=x$
5	Subtraction from a Constant	55.80 - 39.90 = ?	$a-b=x$
		55.80 - 20.95 = ?	$a-c=x$
		55.80 - 9.35 = ?	$a-d=x$
6	Multiplication	124 × 36 = ?	$a\times b=x$ or $(a)\ (b)=x$ or $ab=x$
7	Constant Multiplicand	1.45 × 43 = ?	$ab=x$
		1.45 × 86 = ?	$ac=x$
		1.45 × 119 = ?	$ad=x$
8	Accumulative Multiplication	39 × 1.10 22 × 2.75 45 × .95 = ?	$ab+cd+ef=x$
9	Three Factor Multiplication	35 × 48 × 19 = ?	$abc=x$
10	Double Mult.	1.50 × 36 and 48 = ??	ab and $ac=x$ and y
11	Multiplication combined with Subtractive Multiplication	(87 × 54) - (48 × 23) = ?	$(ab)-(cd)=x$
12	Division	385 ÷ 15 = ?	$\frac{a}{b}=x$
13	Division combined with Mult.	(625 ÷ 25) 36 = ?	$(\frac{a}{b})\ c=x$
14	Multiplication combined with Division	(36 × 24) ÷ 13 = ?	$\frac{ab}{c}=x$

UNIT NO. 4

FIGURE WORK CLASSIFICATION BY FORMULA

The Monroe Adding-Calculator can be applied to the figure work of all lines of business because it handles in a direct positive and easy manner the four fundamental operations of arithmetic. We know from our knowledge of Monroe Calculators that basic arithmetic only has two fundamental operations with variations of same - addition and subtraction.

If we stop to think of all these lines of business and their particular figure work, we are apt to feel that our business is a complicated one because how is it going to be possible in a short time for us to learn all of this figure work. We know that over a period of years, we could probably become expert in the figure work of many lines of business but how can we get this knowledge in a short time.

Fortunately, however, as we stated before, all figure work is based on addition and subtraction and variations of those two fundamental operations, therefore, since that is true, we can easily group many types of figure work under certain basic formulas described in Unit 3 with some variations of these formulas.

When we thoroughly understand this grouping and know how to classify our prospect's figure work under certain basic formulas it simplifies our job of learning the figure work of business. When we also realize how few basic formulas are necessary to classify the figure work of business it simplifies our job again, regardless of the fact that each line of business uses different terms and sizes of amounts in their individual figure work requirements.

GROUPING BUSINESS FIGURE WORK BY BASIC FORMULA

We will now illustrate this simplification of figure work classification by giving you some groupings of figure work by formula, using the basic formulas or adaptations of same which were outlined in Unit 3. The groupings by formula given in this Unit 4 are not by any means all inclusive of all figure work in business. They are merely illustrative of what you can do and can be increased in scope by further experience.

Group A Basic Formula No. 9 $abc = x$

MARKET	INDIVIDUAL PROBLEM
Hardware	12 Pcs. Pipe -- 13'5" long @ $ .18½ ft. = ?
Wholesale Paper	21,757 Sheets -208# Paper @ $ .1875 per lb. = ?
Wholesale Coal	2,325 Long Ton @ $12.50 per Short Ton 2,325 × 12.50 × 1.12 = ?
Bank Interest	Day Rate × Days × Principal = Interest .194444 × 23 × 5.275 = ?
Dairy	37½# 28½ Test $ .485 per lb. = ?
Lumber	12.467 Bd. Ft. × 38 Pcs. × $28.50 M = ?

Group B Basic Formula No.13 $(\frac{a}{b})c = x$

MARKET	INDIVIDUAL PROBLEM
Grain	63,420 lbs. Wheat @ $1.25 Bu. = ?
Retail Trade	5,642 Articles @ $5.75 Doz. = ?
Coal	24,680 lbs. @ $15.50 Gr. Ton = ?
Insurance - Return Premium Odd Term	$\frac{279}{381}$ of $69.00 Premium = ?
Steel and Iron	479,412# Steel @ $24.35 Gr. Ton = ?
Oil	157# Oil #2 @ $ .41 per gal. based on 7½# per gal. = ?

Group C Basic Formula No.10 ab and $ac = x$ and y

MARKET	INDIVIDUAL PROBLEM
Department Store Cost & Retail Invoice	27 Items @ $2.75 Cost & $4.55 Retail = ? and ?
Insurance Agents & Co. Commissions	Premium $25.17 Agent's Comm. 15% = ? and ?
Insurance Earned & Return Premium Short Rate	Premium $489.50 - 93% Earned = ? and ?

Group D Basic Formula No.14 $\frac{ab}{c} = x$

MARKET	INDIVIDUAL PROBLEM
Bank Interest	$32,500. 35 Days Rate 2 7/8% Prin. × days ÷ Reciprocal = ?
Retail-Finding Total Retail based on 15% Profit on Retail	125 Articles @ $3.65 Cost No. Articles × Cost ÷ .85 = ?

Group E Basic Formulas Nos. 8 & 11 $(ab)(cd)(ef) = x$ $(ab) - (cd) = y$

Invoices - Discounts and Freight Allowances for:

Furniture
Stationery
Grocery
Textile
Hardware
Iron and Steel
Lumber
Oil
Coal
and many others

Miscellaneous Formulas Adaptable for Grouping

NO.	MARKET	INDIVIDUAL PROBLEM	FORMULA
1	Insurance Prorata Cancellation	$(44.42466 - 44.21370) \times 119.25 = ?$	$(a-b)c = x$
2	Lumber	$\frac{8' \times 58 \text{ pieces}}{1.5 \text{ factor}} \times \$45.25 \text{ M} = ?$	$(\frac{ab}{c})d = x$
3	Cooperage	23950 Staves @ \$26.30 M at $4\frac{1}{4}$ basis 4.85 Average $\frac{23.950 \times 4.85}{4.25} \times 26.30 = ?$	$(\frac{ab}{c})d = x$
4	Oil Purchases	18416 Bbls. $2\frac{1}{2}\%$ Bs. 1/16 Royalty = ?	$a - (bc) - (de) = x$
5	Oil Run	67432 Ga. 67° less .0028 = ?	$a - (bc) = x$
6	Estimating Cubic Measurement	$\frac{46'6" \times 15'9" \times 4'3" \times \$2.45}{27} = ?$	$\frac{abcd}{e} = x$
7	Other types estimating	1'6" × 11" × 2'7" = ?	Formula No.9 $abc = x$
8	Dairy - Over run	1097# Cream Used 1331# Butter Produced (1331 - 1097) ÷ 1097 = ?	$\frac{a-b}{b} = x$
9	Interest	$\frac{5,000 \times 48 \times 3\frac{1}{2}\%}{365} = ?$	$\frac{abc}{d} = x$
10	Retail Mark-up & % Mark-up	Cost 550.30 Retail 785.15 = ?	$\frac{a-b}{a} = x$

MONROE FORMULA PROBLEM SIMPLIFICATION

UNIT NO. 5

GROUPING OF FORMULAS BY MACHINE OPERATION

When we translate formulas into actual machine operation, we find that many of these formulas fall into the same group. This grouping of formulas according to machine operation is another evidence of the simplification of figure work. We have already discovered in previous units of this course that despite the varied lines of business, their figure work translated into symbols and formula can be handled with only a few basic formulas.

This unit suggests a few groupings of basic formulas to show you that machine operations can be also classified into a comparatively few basic operations thus simplifying business problems. Here are a few examples which illustrate this simplification.

EXAMPLE NO. 1

GROUPING OF FORMULAS

Formula No. 1 Addition $a + b = x$
Formula No. 3 Subtraction $a - b = x$

SIMILARITY IN MACHINE OPERATION

Here is an interesting example of grouping formulas according to machine operation. The amount represented by the symbol "a" is always placed in the lower dials first in both formulas. Then the handling of symbol "b" is merely a question of whether you use the plus or minus bar, and the value of "x" is always in the lower dials.

EXAMPLE NO. 2

GROUPING OF FORMULAS

Formula No. 6 Multiplication $ab = x$
Formula No. 7 Constant Multiplicand $ab = x$
$ac = x$
$ad = x$
Formula No. 8 Accumulative Multiplication $ab + cd + ef = x$

SIMILARITY IN MACHINE OPERATION

This group offers another interesting combination of similar machine operations since they are all a multiplication group. The symbols in each term are individually keyboard and upper dials factors. In formula No. 6, the factor represented by the symbol "a" is on the keyboard and the factor represented

by the symbol "b" is in the upper dials. The unknown symbol "x" will in each case be found in the lower dials. The only differences in machine operation occur in Formula No. 7 where keyboard clearance is unnecessary and in Formula No. 8 where lower dials clearance is unnecessary.

EXAMPLE NO. 3

GROUPING OF FORMULAS

Formula No. 12 Division $\frac{a}{b} = x$

Formula No. 14 Multiplication combined with Division $\frac{ab}{c} = x$

Formula No. 6 (Misc.) Estimating $\frac{abcd}{e} = x$

Formula No. 8 (Misc.) Dairy $\frac{a - b}{b} = x$

Formula No. 9 (Misc.) Interest $\frac{abc}{d} = x$

Formula No. 10 (Misc.) Retail $\frac{a - b}{a} = x$

SIMILARITY IN MACHINE OPERATION

This group of formulas is basically the same machine operation for the same reason that those in Example No. 2 were the same. These formulas are all based on division and those in Example No. 2 were based on multiplication. The symbol numerator of all these fractions in numerical form eventually appear in the lower dials by a process of multiplication, addition, or subtraction. And the symbol denominator in numerical form is always set on the keyboard. The unknown quantity "x" in numerical form always appears in the upper dials. Here are the slight differences in machine operation.

Formula No. 12 requires the numerator to be added. Formula No. 14 requires a multiplication of the elements in the numerator. Formulas No. 6 (Misc.) and No. 9 (Misc.) require a three or four-way multiplication of the numerator elements before the real numerator appears in the lower dials. Formulas Nos. 8 (Misc.) and 10 (Misc.) require an addition and subtraction to arrive at the correct numerator in the lower dials and since the denominators differ we - from a machine operation standpoint - short-cut Formula No. 10 (Misc.) by changing the signs of the numerator as follows:

$$\frac{-b + a}{a} = x$$

EXAMPLE NO. 4

GROUPING OF FORMULAS

Formulas No. 1 (Misc.)	Insurance	$(a-b)\,c = x$
Formula No. 5 (Misc.)	Oil Run	$a - (bc) = x$

SIMILARITY IN MACHINE OPERATION

This group of formulas differs in respect to machine operation from those groups previously described in the fact that at first glance it is not fully evident that there is a similarity in machine operation. But a closer study of these two formulas discloses this similarity that exists.

In Formula No. 1 (Misc.), we first add and subtract the term enclosed in the parentheses. Then multiply the result in the lower dials through keyboard transfer or dial transfer by the value of "c" with the value of "x" in the lower dials. In Formula No. 5 (Misc.), the processes are the same except the multiplication takes place first, reversing the process in Formula No. 1, and then a double subtraction and addition reversing again the process in Formula No. 1

EXAMPLE NO. 5

GROUPING OF FORMULAS

Formula No. 13	Division combined with multiplication	$(\frac{a}{b})\,c = x$
Formula No. 14	Multiplication combined with division	$\frac{ab}{c} = x$

SIMILARITY IN MACHINE OPERATION

This group of formulas can be classified from a machine operating standpoint as simultaneous multiplication and division formulas. There are several machine methods for handling figure problems using these formulas. For example, the straight method without simultaneous operation, and if simultaneous operation is used the build-up, complementary or negative methods, can be used. The slight differences between the two formulas are apparant. In formula No. 13, the term in parentheses is handled by division leaving the upper dials result as a multiplier for the numerical value of the symbol "c" with upper dials restoring to zero as a proof.

In Formula No. 14, the numerator is secured through multiplication in the lower dials followed by a division of that numerator by the numerical value of the symbol "c". In other words, the arithmetical operations are reversed in these two formulas, yet the formulas are similar in machine operation.

UNIT NO. 6

MONROE MODEL SELECTION BY FORMULA OF PROBLEM

The use of formulas not only simplifies your study of a figure problem as is evident by the preceding units of this course but in many cases it definitely indicates the proper Monroe calculator model to recommend for the most efficient handling of the problem;particularly, if the volume justifies a particular model. We list a few cases to illustrate this point.

CASE NO.	FORMULA	TYPE OF WORK	MODEL TO RECOMMEND	EXPLANATION
1	Formula No. 7 $ab = x$ $ac = x$ $ad = x$	Constant Multiplicand	LA-6 or AA-1	This type of work in volume can be shortened by locking a constant in the machine.
2	Formula No. 8 $ab + cd + ef = x$	Accumulative Multiplication	Any Series 3 type	This type of work is frequently checking invoices and may require an accumulation of multipliers.
3	Formula No. 9 $abc = x$	Three Factor Multiplication	LA-6	There is no better Monroe Model because the multiplier for the second calculation remains in the lower dials to be used in automatic multiplication.
4	Formula No. 10 ab & $ac = x$ & y	Double Multiplication	Any 10-column model	Due to capacity, all jobs involving double multiplication require a 10-column model.
5	Formula No. 11 $(ab) - (cd) = x$	Multiplication combined with subtractive multiplication	AA-1	If there is any great quantity of subtractive multiplication Model AA-1 is the only model which has negative auto. mult.
6	Formulas Nos. 13 and 14 $(\frac{a}{b})\ c = x$ $\frac{ab}{c} = x$	Combined Division and multiplication	Any 10-column model with Series 3 Dials & Auto.Div.	Since these operations are generally dual keyboard set-ups a 10-column model is essential. If negative auto. operation is desired, auto. division is important and Series 3 dials to give us another answer often required.

MONROE FORMULA PROBLEM SIMPLIFICATION

UNIT NO. 7

PROBLEM SOLUTION SIMPLIFIED BY FORMULA

SPECIAL SIGNS FOR PROBLEM DATA

Before a figure problem can be simplified by formula, you must have the essential facts regarding the problem. Frequently the problem will be such that you will want to study it in your own office. In any case, before you can formulize the problem, the relationship of all factors in the problem must be known in a logical and quick-reading manner.

The following special signs have been standardized and adopted to assist you in preparing a figure problem for formula simplification. It should become as much of a habit for you to use these signs as it is for you to use the signs listed in Unit No. 1 or to use a period, comma or question mark in ordinary correspondence.

DESCRIPTION	INSTRUCTION	ILLUSTRATION OF PROBLEM ANALYSIS SIGN
1 Constant Factor	Circle the constant amount.	.1875
2 Given Figures	Enclose all given amounts in straight lines.	$\boxed{98.04}$
3 Figures produced that are unknown at beginning of problem and order of production.	Each amount is plain with number in circle preceding the amount to indicate order of production.	1 36.85 3 119.73 2 9.50
4 Intermediate figure. Unessential except to secure result by hand calculation and we can eliminate writing.	Underline amount.	35.86
5 Several unknown results secured simultaneously.	Extend numbered circle described in #3 above by line and arrow to plain circle placed to left of 2nd result produced simultaneously with first result.	4 → 5.83 → 11.90

DESCRIPTION	INSTRUCTION	ILLUSTRATION OF PROBLEM ANALYSIS SIGN
6 Columns or amounts eliminated which were given in original problem but eliminated by formula simplification.	Place a row of x's in the space provided for the amount or column.	Amount xxxxx Column |xxxx|

WHY, WHAT & WHERE ARE SIGNIFICANT QUESTIONS

Before you can successfully use the special signs for securing the facts regarding the figure problem, intelligent questions must be asked which can all be summated in these three.

WHY DO YOU NEED THIS FIGURE? Either you will find they do not need the figure which thereby changes your formula or there will be disclosed the real need for the figure which makes for a clearer understanding for the formula.

WHAT DO YOU DO WITH THIS FIGURE? The answer to this question may disclose that writing this figure in the problem is a needless duplication. The honest answer to this question helps to determine if the figure can be eliminated which would then change the formula. It also supplies information for listing machine promotion.

WHERE DOES THIS FIGURE COME FROM? It is highly important to know the source of a figure. It might disclose that this figure can be eliminated because it has been produced elsewhere.

WHAT ARE FOOLISH FIGURES? Any figure which can be eliminated from a calculation or from being transcribed to paper is a foolish figure, if it is retained for calculation or for entry to any media. Your prospect will concede that such a figure is a foolish figure if you can show that it can be eliminated.

The formula method of problem examination not only simplifies the problem but does disclose graphically after the questions WHY, WHAT and WHERE have been honestly answered where foolish figures occur and can be eliminated thus giving further simplification to your final job of machine application by formula.

PREPARING THE FIGURE PROBLEM FOR FORMULA SIMPLIFICATION

THE GIVEN PROBLEM was a payroll bonus problem. The prospect used an arithmetical formula to solve the problem as follows:

$$\left[\frac{\underset{.222}{\text{Rate}} \times \underset{520.}{\text{Quantity}}}{\underset{67.}{\text{Time}}} - 1\right] \frac{\underset{67}{\text{Time}}}{\underset{240}{\text{Standard Constant}}} = .201$$

There were two constants in this formula the - 1 and the 240. The purpose of the - 1 was to remove the 100% since Rate × Quantity ÷ Time resulted in a percent over 100%; namely, 1.7229 or 172.29%. Bonus was only paid on everything over 100%, so the -1 removed the 100%. This information was obtained by asking the questions WHY, WHAT, and WHERE.

FORMULIZING THE PROBLEM WITH SYMBOLS

Let R = Rate
Q = Quantity
T = Time
C = Constant Standard
X = Bonus Rate

Then we have $$\left[\frac{RQ}{T} - 1\right] \frac{T}{C} = x$$

We then simplify by removing brackets $$\frac{RQT}{TC} - \frac{T}{C} = x$$

We clear fractions $$RQT - T^2 = TCX$$

We divide both sides by T $$RQ - T = CX$$

We divide both sides by C and finally have $$\frac{RQ-T}{C} = x$$

ARITHMETICAL SUBSTITUTION OF FORMULIZED PROBLEM

$$\frac{(.222 \times 520)-67.}{240.} = .201$$

Compare this with the original Arithmetical Formula

$$\left[\frac{.222 \times 520.}{67.} - 1\right] \frac{67}{240} = .201$$

and note that the final solution contains one multiplication, one subtraction and one division. The original had two multiplications, one subtraction and two divisions- a saving of one multiplication and one division.

UNIT NO. 8

MACHINE PROPOSALS AND APPLICATIONS ULTIMATE OBJECTIVE

It has been the experience of the Monroe Calculating Machine Company for many years that their most successful sales representatives have used calculating machine proposals and applications to expedite the securing of orders. Unit No. 7 gives a good illustration of the value of symbolizing in formula form a figure problem. And it is evident in the example given in that unit that having arrived at the final formula, it would not be difficult to arrive at a machine application using the proper model.

DESCRIPTION OF PROPOSAL - FORM 681-S

The expression "681-S" used by Monroe representatives for years has become, through constant use, a synomonous term with the word "Proposal". This form is composed of a simple cover stock on which can be placed the name of the prospect and the address of the branch office. Accompanying forms are a white sheet - Form 862-S-1 - used for writing the machine application and a green tissue sheet with the same form number to be used for carbon copies.

The presentation to the prospect of this form properly filled in with the machine application and a letter proposal makes a tremendous impression. It is business-like, dignified and very effective in reaching a favorable decision for Monroe equipment.

We suggest that you not only show your suggested method in formula form and in a machine application, but that you also briefly outline the present arithmetical or machine method of handling the problem so that the prospect can draw the comparisons between the two and better judge the savings in labor and time that you are offering him.

TERMINOLOGY OF MACHINE APPLICATIONS

The many years of experience in writing and presenting machine applications in various forms - proposals, instruction leaflets and books and special application books - have developed a common terminology for Monroe applications.

Every Monroe representative who has received preliminary training on Monroe calculators has no doubt absorbed much of this terminology unconsciously as they studied the various books of instruction. Therefore, it should be unnecessary in this course to do more than point out a few of these common standardized terms for describing

certain machine operations. A uniform terminology is important because it insures a universal understanding of machine operations and is readily understood by all Monroe representatives and prospects and users. Here are a few terminologies that are standard.

OPERATION	TERMINOLOGY
1 Keyboard Operations	SET the amount on keyboard, not depress, or put or any other term.
2 New Amount on Keyboard	CHANGE KEYBOARD SET-UP
3 Carriage Position	MOVE OR SHIFT carriage to "3" POSITION or with carriage in "5" POSITION not move or shift carriage three places.
4 Operating Bars	DEPRESS plus or minus bar not strike or hit the plus or minus bar.
5 Automatic Levers - Mult. and Div.	PUSH divide lever, not throw divide lever.
6 Clearances	Always specify clearances to be made if they are partial followed by the word "only". If entire machine is to be cleared, specify CLEAR ENTIRE MACHINE.
7 Paragraphing the Application	Each paragraph of the machine application should contain instructions only for a major machine operation. Never have two major machine operations; such as, a multiplication and division in the same paragraph. Then identify each paragraph with the following expression: Step 1, Step 2, Step 3, etc.

EXAMPLES OF MACHINE APPLICATIONS COMBINED PROBLEM FORMULAS

The sole purpose of this course of eight units is to provide Monroe representatives with a technique and method of selling calculators, which if understood and practiced, will enable each representative to sell more machines. We know from many years of experience that the use of formulas will simplify your study of figure problems and the machine applications developed. If you use this method of selling calculators you will establish yourself as a consultant for your users, instead of an ordinary salesman and you will be immune from serious competitive influence.

As a summation of what you have learned in all previous units, we have taken from our files of machine applications that have sold calculators a few examples and show you both the arithmetical method and the machine method of working the problem with a formula expression for both arithmetical and machine method.

EXAMPLES OF MACHINE APPLICATIONS

A - Example What gross price will a Plumbing Fixture House, that must realize a 10% profit on its costs, quote a contractor who insists upon a 10% discount? The supplies in question cost the Plumbing House $3,338.00.

ARITHMETIC METHOD AND FORMULA

Formula $$\frac{a + (a.10)}{1.00 - c} = x$$

Scratch Pad

```
       3338.00
        333.80
  .90)3671.80000    (4079.777
      360
       718
       630
        880
        810
         700
         630
          700
          630
           700
           630
            70
```

MACHINE METHOD AND FORMULA

Formula $$\frac{a\ (1.10)}{.90} = x$$

MONROE METHOD

Using any auto-dividing Model	Decimals:	Upper Dials	3
		Keyboard	2
		Lower Dials	5

STEP 1 With carriage in "4" position, set 3338.00 on extreme right of keyboard. Multiply by 110% or 1.100. Clear keyboard and upper dials only.

STEP 2 With carriage in "7" position, set 90% or .90 on extreme right of keyboard. Push divide lever. Upper dials read 4079.777 or 4079.78 value of x.

a

B - **Example:** A building constructed at a cost of \$48,750.00 is sold at a profit of \$7,125.00. What per cent of profit was realized on the selling price? On the cost price?

b

ARITHMETIC METHOD AND FORMULA Formula $\frac{b}{a+b} = x$ and $\frac{b}{a} = y$

Scratch Pad

```
48,750)7,125.00000(14.615          48,750
        4 875 0                     7,125
        225000                     55,875)7125.000000(12.751
        195000                             55875
         300000                            153750
         292500                            111750
          75000                             420000
          48750                             391125
          262500                             288750
          243750                             279375
           18750                              93750
                                              55875
                                              37875
```

MACHINE METHOD AND FORMULA Formula $(a + b)\,x = b \qquad \frac{b}{a} = y$

NOTE: This formula is possible due only to machine method. In additive division, we actually are multiplying the keyboard amount by an unknown factor or value of x.

MONROE METHOD

Using any auto. dividing Model Decimals: Upper Dials 5, Keyboard 0, Lower Dials 5

STEP 1 With carriage in "6" position, set 48750 on extreme right of keyboard. Depress plus bar once. Clear keyboard and upper dials only.

STEP 2 Set 7125 on extreme right of keyboard. Depress plus bar once. Copy to keyboard from lower dials 55875. Depress minus bar once, thus clearing upper dials and proving keyboard transfer.

STEP 3 Move carriage to "5" position and produce 7125.18000 in lower dials by additive division.

STEP 4 Upper dials now read .12752 or 12.75% profit on selling price, value of x. Clear upper dials and keyboard only.

STEP 5 With carriage in "5" position, set 48750 on right of keyboard. Push divide lever.

STEP 6 Upper dials now read .14615 or 14.62% profit on cost value of y.

c b

C- **Example :** A retailer bought 142 yards of cloth for \$163.44 and sold it at \$1.39 per yard. How much was the profit per yard to three decimals? a

ARITHMETIC METHOD AND FORMULA — Formula $a - (\frac{b}{c}) = x$

Scratch Pad

```
                    1.39
142)163.44        (1.151
    142            .239
     214
     142
      724
      710
       140
       142
```

MACHINE METHOD AND FORMULA — Formula $\frac{-b + ca}{c} = x$

MONROE METHOD

Using any 8-column Monroe with auto. division

Decimals:	Upper Dials	3
	Keyboard	2
	Lower Dials	5

STEP 1 Set 163.44 on extreme right of keyboard with carriage in "4" position. Depress minus bar once. Clear keyboard and upper dials only.

STEP 2 Set 142.00 on keyboard at decimal. Multiply left to right by 1.390 in upper dials. Lower dials now show 33.94000. Clear upper dials only.

STEP 3 With carriage in "3" position, push divide lever. Upper dials show .239 profit per yard, value of x.